Cooling Optimization

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Collaboration ITT
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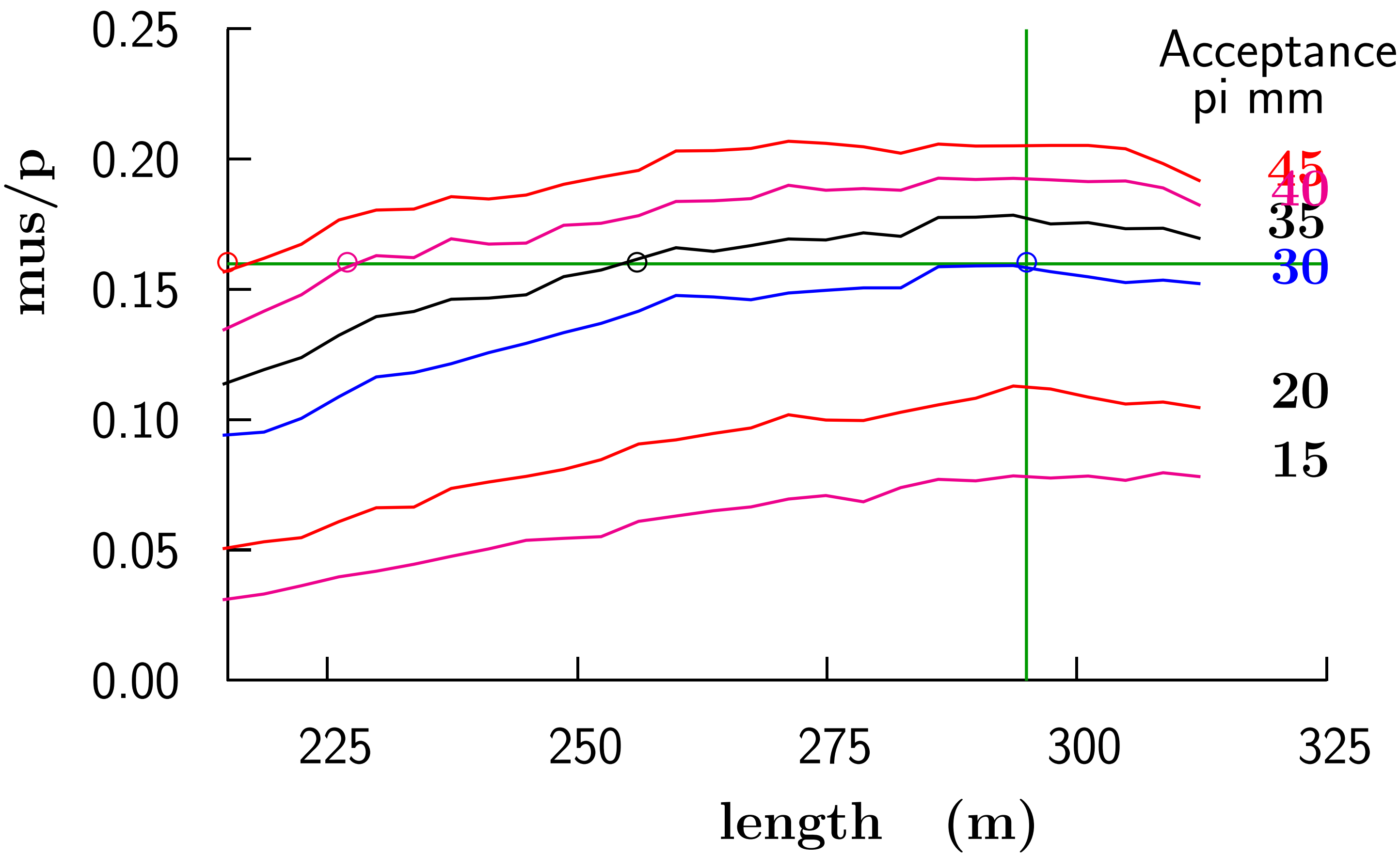
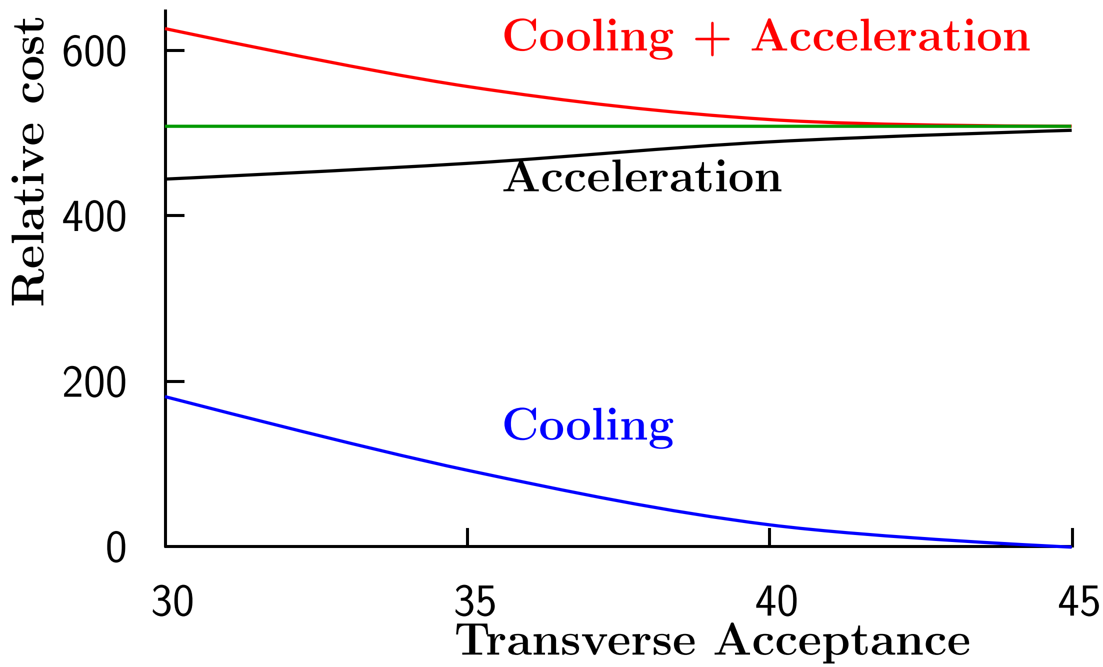
1. For fixed nu flux: cooling vs aperture
2. For fixed nu events: cooling vs detector
3. c.f. Lyon Goal for useful muon decays per year
4. Conclusion

Cooling vs Accelerator Acceptance

- Using US Study 2a (APS Neutrino Matrix) as example
- Use ICOOL for performance simulation
- Determine how much cooling needed to get same performance with larger apertures



- Use J.S.Berg estimates of FFAG cost vs aperture
- Assume other acceleration and collider ring costs vary in the same proportion
- Plot cost of cooling plus acceleration vs acceleration acceptance



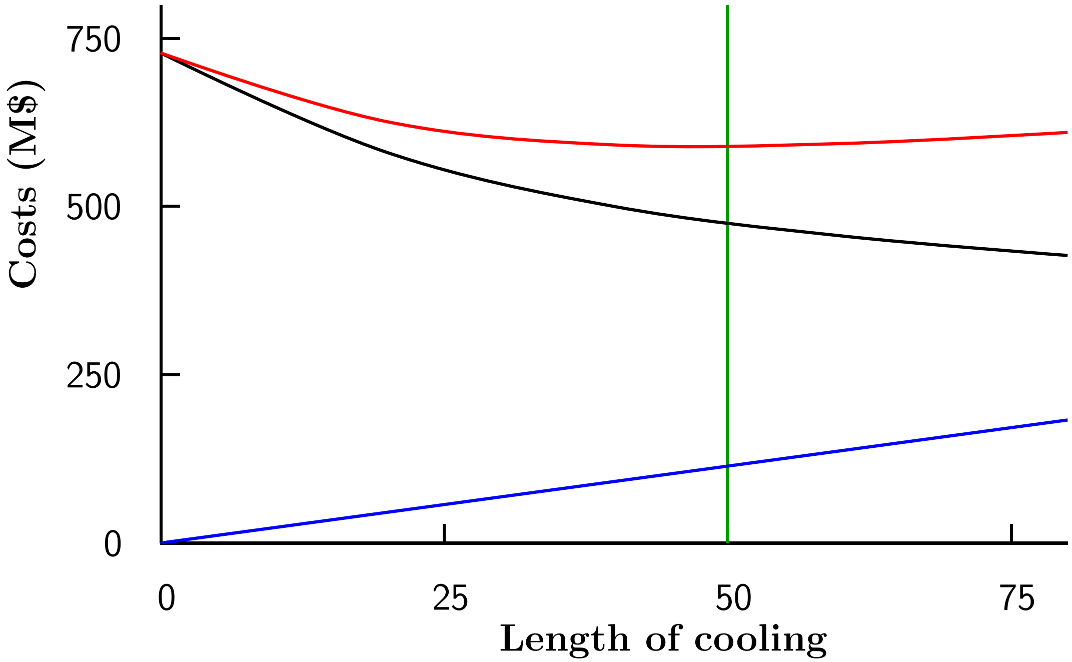
- Suggests minimum cost with 45 pi mm acceptance and NO cooling
- But a 45 pi mm acceptance FFAG has time of flight problems
- And cost of lower energy acceleration probably rise faster with acceptance than FFAG
- This conclusion is probably moot

Some Advantages of using No Cooling

- No field "flips" needed
- Less dependence on use of RF in magnetic fields
  - Relatively easy to design with fields less than 0.5 T
- Reduced Requirement on capture acceptance
  - Smaller aperture phase rotation RF
  - Could reconsider 400 MHz rf
  - Smaller or lower field focusing in drift
  - Lower Capture Field

Optimization of Cooling vs Detector Size

- Assume base detector costs (two detectors) is 500 unloaded M$
- Scale detector size (and cost) to achieve same number of events with different cooling lengths



- Minimum total cost minimum at 50 m (vs. 80 m)
- Saving for Factory of 70 M$
- Saving for Factory and Detector 17 M$
- Saving at minimum relative to no cooling and larger detectors: 136 M$

c.f. Lyon Goal for Useful Muon decays per year

- With 4 MW proton power
- Assume captured pions per proton GeV = .039 (S2a value)
- 60% straight over circumference for two detectors
- 10^7 seconds per year
- Include 20% loss for matching, injection, etc
- Compare with Lyon NuFact goal of 10^{21} Useful decays per year

case	cooling	trans acc pi mm	signs	mu/pi	mu/year $\times 10^{21}$
Japan	no	30	1	0.08	.22
Cern 44/88	yes	15	1	0.066	.24
US Study 2	yes	15	1	0.17	.62
US Study 2a	yes	30	2	0.17	1.22
US Study 2a	no	30	2	0.09	.72

- Only Study 2a with 2 detectors reaches the 10^{21} goal
- With 50 m cooling, still get 1.1 10^{21}

Conclusion

- Optimization of accelerator aperture vs cooling suggests no cooling is best
- But the required acceptance is probably impractical
- Should always use the largest practical acceptance, and we do

- Optimization of cooling vs detector cost suggest moderate cooling (50 m) is optimum
- With such "moderate" cooling S2a still achieves Lyon Goal of 10^{21} useful muon decays per year
- Should reduce cooling length from 80 to 50 m and save 70 M$

- This discussion may have to be re-visited if magnetic field dependence of cavities is too serious